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Operator Selection for Unmanned Aerial Vehicle Operators: A Comparison of Video Game Players and Manned Aircraft Pilots

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With the ability to remotely identify enemy activity, track potential targets for extended periods of time, and safely engage the enemy from ground control stations located thousands of miles away, unmanned aerial systems (UAS) have witnessed unprecedented popularity among military leadership and operators. Unfortunately, the accelerated UAS operations tempo has now outpaced current operator training regimens leading to a potential shortage of qualified UAS pilots. This study attempted to discover whether video game players (VGPs) possess superior UAS-relevant cognitive skills when compared to manned aircraft pilots and therefore possibly serve as a viable operator alternative to UAS pilots.

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SUMMARY

Highly popular unmanned aerial system (UAS) platforms such as the MQ-1 Predator and MQ-9 Reaper have experienced an exponential rise in operationalflight hours as demand continues to increase. The corresponding accelerated UAS operations tempo has now outpaced current operator training regimens leading to a shortage of qualified UAS pilots. In an attempt to find a surrogate to replace the use of manned aircraft pilots as UAS operators, this study evaluated video game players (VGPs), pilots, and a control group on a set of UAS operation-relevant cognitive tasks. The results indicated that pilots significantly outperform the VGP and control groups on multi-attribute cognitive tasks. Specifically, the pilots achieved significantly better performance when compared to the VGP and control groups on a simulated aircraft multi-task including 4 different, simultaneous cognitive tests known as the multi-attribute task battery (MAT-B). However, the VGPs outperformed pilots and control subjects on cognitive tests related to visually acquiring, identifying, and tracking targets, presumably due to extensive action video game play. Likewise, both VGPs and pilots performed similarly on the UAS landing task, but significantly outperformed the control group. As a result, it appears that cognitive skills learned in video game play may transfer to novel environments such as UAS operations and strengthen or improve performance in specific realms, such as target tracking and aircraft control, over individuals with no video game experience. Additional research should be conducted to explicate the relationship between UAS-relevant skill performance and extensive action video game play.

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1.0 INTRODUCTION

With the ability to remotely identify enemy activity, track potential targets for extended periods of time, and safely engage the enemy from ground control stations located thousands of miles away, unmanned aerial systems (UAS) have witnessed unprecedented popularity among military leadership and operators. This has consequently led to a seemingly insatiable demand for more systems and operators. Data from the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (2005) has shown UAS flight hours rose from a couple thousand in 1996 to approximately 115,000 in 2005. In particular, flight hours on the popular RQ-1/MQ-1 Predator tripled from 2003 to 2007 (Brook, 2007). Unfortunately, this accelerated UAS operations tempo has now outpaced current operator training regimens leading to a shortage of qualified UAS pilots.

The current Air Force guidelines require that the RQ-1/MQ-1 Predator must be operated by fighter/bomber pilot or a Weapons Systems Officer (WSO). Hence, candidate pilots must successfully complete the lengthy and arduous manned aircraft training and be qualified as combat pilots. Consequently, they require a medical and physical certification that may not be necessary considering that they do not have to cope with the environmental and physical stressors associated with operating a manned aircraft (Triplett, 2008). Next, they must meet a second level of qualification by taking 3 months of additional training for UAS operations. This intensive training and qualification curriculum may unnecessarily limit the pool of individuals able to command UAS systems. In fact, a recent news article by Shanker (2008), released a quote from Defense Secretary Robert M. Gates indicating this policy "has limited how many of these aircraft [the Air Force] can deploy," and that military services need to "re-examine their culture and their way of doing business," and "think outside the box in problem solving." Furthermore, Schreiber, Lyon, Martin, and Confer (2002) concluded that non-pilots with minimal piloting training could be just as competent as manned aircraft pilots in operating UAS's. With demand high and available operators low, the Air Force continues to investigate methods of reducing UAS operator training times. Specifically, investigations of surrogate UAS operators are of high interest.

With prevalent use of LCD monitors, keyboard and mouse control inputs, online "chat" functions, and game-like flight stick/throttle, Predator UAS ground control stations (GCS) have often been compared with the traditional video game environment. Given these similarities, it is reasonable to question whether video game experience would benefit UAS operators. Conceivably, non-pilots with video game experience may even be better suited for this career field due to the vast differences between the manned and unmanned aircraft control environments. For example, unmanned systems do not include motion cueing, auditory feedback, or wide fields-of-view that manned pilots use for situational awareness, perception of velocity, and perception of altitude. Recent research has suggested video game players (VGPs) have superior performance on several cognitive abilities when compared to non-video game players (NVGPs) that may serve to benefit UAS operations. Castel, *et al*. (2005) suggested video gamers can track more targets and benefit from superior stimulus response mapping in visual tasks. Additionally, experienced VGPs enjoy enhanced spatial skills (Dorvil & Pepin, 1986), improved psychomotor skills (Griffith et al., 1983), and quicker reaction times (Yugi, 1983). Perhaps more importantly, these skills seem to transfer to other cognitive tasks and environments (Frederiksen & White, 1989; Gopher, Weil, & Bareket, 1994; Green and Bavelier, 2007). Boot, et al., (2008) found experienced VGPs exhibited a variety of cognitive differences when compared to NVGPs such as the ability to track targets moving at increased velocities, superior ability to detect subtle variations in objects stored in short term memory, faster attention switching between tasks, and improved efficiency in a mental rotation task. In a preliminary study, McKinley et al. (2008) compared VGPs and pilots on a series of UAS relevant cognitive tests including visual search, mental rotation ability, complex decision making, and landing performance using a Predator simulator. Of all of these cognitive and behavioral measures, the only differences found between pilots and VGPs were in the visual search and landing measures. Pilots performed better on a single subset of the landing performance metric, and VGPs had faster visual search times. Considering that with very little training the VGPs performed almost at par with pilots on the UAS landing task, the initial evidence suggests VGPs may hold some inherent cognitive skill advantages that are useful in the UAS control environment.

A follow-on investigation conducted by Triplett (2008) utilized extensive interviews with manned aircraft pilots, UAS pilots, and experienced video game players to identify skills and characteristics that are critical in each of these three environments. Examining the resulting cognitive skills, Triplett was able to identify those that were common to all three environments. The present research is intended to answer the question of whether a non-video gamer/non-pilot or a video gamer/non-pilot can operate a UAS just as effectively as a pilot by probing eight of the skills identified by Triplett (2008). If either or both of these groups can perform comparably to the pilot group then a viable option for UAS support is available to decrease the immense demands on current pilots.

2.0 METHODS

2.1 Subjects

Thirty male and female subjects volunteered to participate in this experiment. All participants were at least 18 years of age and were recruited from the Dayton, OH area including Wright-Patterson Air Force Base, Wright State University, the University of Dayton, and the Air Force Institute of Technology. Participants received $10/hr as compensation for their time, although active duty military members were required to complete an "Application for Off-Duty Employment" (AF Form 3902) in order to receive compensation in accordance with existing military regulations. Subjects were also divided into three groups of equal size (10 each) based on their responses to a questionnaire designed to assess the extent of their piloting and video game experience. The first group comprised of experienced pilots while the second group consisted of video game players (VGPs). The third group served as the control and contained subjects with little to no video game experience and no pilot experience. Video game experience was quantified by the type of video game, frequency of play, and history of play. To qualify for participation as a VGP, subjects were required to have played action video games a minimum of 3-4 days a week (at least one hour per session) over a period of at least 6 months. In addition, all subjects were required to have normal use of both arms and legs. Those with special cognitive or physical needs were subject to exclusion from participation in the study. Finally, each participant needed to possess basic computer skills and meet the study training requirements within a maximum of 8 training sessions.

2.2 Apparatus

A constructed Predator Unmanned Aerial Vehicle (UAV) Ground Control Station (GCS) Simulator was used to simulate landing maneuvers. Two 19-inch cathode ray tube (CRT) monitors were included to display the map-view and camera-view for the simulation. The positions of the monitors were the same as that of the operational Predator GCS (top monitor at 15^o downward angle 44.5-inches above the table, bottom monitor perpendicular with the table). The map-view was displayed on top monitor while the camera-view was displayed on the bottom monitor. The station is complete with a high-back office chair with an adjustable seat height. Flight control included a replicated Predator GCS flight stick and throttle developed by High Rev Simulators (Lancaster, CA).

All other performance tasks were presented on a standard desktop computer with touch-screen monitor. Subjects were seated in a standard office chair during performance of these computer-based tasks. Responses were secured with a either a mouse or the touch-screen monitor.

2.3 Stimuli

A subset of cognitive skills (situational awareness, precise timing, judgment, fine motor coordination/control, visual information processing, memory, complex cognitive multitasking, and spatial awareness) were selected from the Triplett (2008) report detailing those necessary in video game play, UAS operations, and manned flight. Eight computer-based tasks were then used to evaluate each subject group's performance on these cognitive skills. Each participant was trained to a learning asymptote where performance varied less than 10% between sessions.

The first three performance tasks were selected from the Cambridge Neuropsychological Assessment Battery (CANTAB) which houses a battery of tasks that probe various basic cognitive functions. The first was termed "rapid visual information processing" (RVP) and was a test of visual sustained attention and working memory. A series of digits (2 through 9) were displayed within a white box located in the center of the screen. The digits were displayed continuously, one at a time, at the rate of 100 digits per minute. The numbers appeared in a pseudo-random order with specific sequences of three numbers such as 2-4-6, 3-5-7, and 4-6-8, appearing at the rate of 16 times every two minutes. The subject was instructed to identify these sequences of digits and respond by pressing the right button on the mouse immediately after the last number in the sequence appeared. The test spanned three minutes, although a two-minute practice session preceded the actual test. Practice session results were not scored and thus not included in any data analyses.

CANTAB's "spatial recognition memory" (SRM) task was used to evaluate the recall of spatial relationships in a two-option forced-choice paradigm. The task displayed a single white square in series of five randomly selected locations on the screen. The subject was instructed to remember each location the square appeared. Afterward, the square was again displayed in the same of five locations, but in reverse order. With each appearance, the square was paired with a second "distracter" square positioned in a location that had not been displayed previously. The subject was required to choose the square appearing in the location that was previously presented, while ignoring the distracter. Correct responses were reinforced with an audio tone and a green check-mark symbol that appeared in the center of the square. Incorrect responses resulted in a lower frequency audio tone and a red "x" within the square. A total of four location sequences were presented in each session.

The third task was a "delayed matching to sample" (DMS) task designed to probe perceptual matching, as well as immediate and delayed visual memory. The subject is presented with a complex arbitrary pattern with four colored quadrants. Four patterns are then presented either simultaneously with the original pattern or following a delay of 0, 4, or 12 seconds, where the original pattern is obscured from view. The subject was required to then choose the one that matched the original pattern. Each subject completed two sets of 20 randomized trials per session that included five simultaneous, five 0-sec delay, five 4-sec delay, and five 12-second delay presentations. Should the subject select the incorrect pattern, an "x" was displayed over the pattern. They would then continue making selections until the proper pattern was chosen.

The forth task is the multi-attribute task battery (MAT-B) described by Comstock and Arnegard (1992). It is comprised of four computerized subtasks that simulate a variety of activities aircrew are required to perform. The first is a visual monitoring task where the subject is required to report changes in displays including two lights that may turn on or off and 4 vertical bars with sliding indicators that occasionally move out of a predetermined "safe zone." Next is an auditory monitoring task that requires subjects to listen for their assigned call sign and complete the instructions that follow (e.g. changing communications frequency). The third subtask is a resource management test that requires participants to route simulated "fuel" into two tanks via pumps that occasionally become inoperable. When such an event occurs, the "fuel" must be rerouted through other paths to maintain the proper level in the two main tanks. Finally, the forth subtask is a two-dimensional continuous tracking task. Here, the subjects must align a randomly moving target circle with a static crosshair in the center of the subtask screen.

Task 5 originates from a custom cognitive task battery developed by NTI, Inc. known as "G-PASS". Titled "Motion Inference," the task was included to probe each subject's ability to rapidly adapt to visual limitations. It consists of a semicircular arc, a moving target light, and a hash mark/stopping point presented against a black background. The target light traverses the curved path from left to right at a constant velocity and then disappears after it negotiates approximately one-third of the arc-segment. The objective is to stop the target on the predetermined stopping point (hash mark) by estimating time interval required for the target to intersect this point based on its velocity before it disappeared. During this time interval, a secondary distracter task is presented. It consists of a set of four random letters inside a box and the subject must determine whether or not the letter set contains a vowel.

The sixth task also was part of NTI, Inc.'s G-PASS cognitive task battery and is termed, "Precision Timing". As in the motion inference task, the screen includes a semi-circular path over which a target dot traverses at a constant velocity. A stopping point (hashmark) is randomly positioned within the last 1/3 of the arc and the subject must stop the light precisely at that point by depressing the trigger button. Harsh mark position and target dot velocities were randomly selected for each trial presentation.

The seventh task is the UAS landing task developed by AFRL/RHA and AFRL/RHPA. The subject flew the simulated Predator aircraft through a series of three waypoints at specified altitudes. After the final waypoint, they were required to approach the landing point on a 4^{o} glideslope and then touchdown on the runway. Performance was assessed through three variables determined at touchdown that must be within the acceptable range: groundspeed (less than 70.0 knots), glideslope root mean square error (RMSE) (less than 20 ft), and vertical velocity (less than -3.67 ft/s).

Last is the complex cognitive decision making task known as "Warship Commander." A two-dimensional display of an aquatic surface, as viewed from directly above, is presented to the subjects on a standard computer monitor. Near the bottom edge of the screen is a grey naval vessel that represents the subject's "ownship." Upon task execution, waves of white aircraft begin entering the scene. By using the point-and-click method with the supplied mouse, targets can be selected and then subsequently identified using the "Identification, Friend or Foe" (IFF) virtual button located at the bottom of the display. Once the IFF button is depressed, the selected aircraft changes from white to one of three colors: red, yellow, or blue. Red denotes an enemy aircraft, yellow indicates the aircraft type is unknown, and blue designates friendly aircraft. Yellow (unknown) aircraft requires further analysis to determine the aircraft type. Specifically, the subject needs to select the aircraft of interest with the mouse and then depress the highlighted number to the left of the communications window that indicates the aircraft's ID. Two seconds after selecting the aircraft, a statement appears in the communications window that indicates whether the aircraft is assumed to be hostile or friendly. Hostile, yellow aircraft require a warning before they can be engaged. This is completed by selecting the aircraft to be warned and then depressing the "Warn" button located to the right of the IFF button within the interface. The aircraft are given 3 seconds to turn away from the subject's "ownship" at the bottom of the screen. If still advancing toward the bottom of the screen after the 3 seconds have elapsed, the subject is required to fire upon the target by depressing the "Fire" button. Likewise, any red (enemy) aircraft are to be fired upon immediately. Blue or yellow friendly aircraft are to be ignored. A score is presented to the left of the IFF button near the bottom of the screen. Points are awarded automatically for target identifications, proper warnings, and destruction of enemy/hostile targets. Incorrect button presses, scores, and event times are recorded by the data logger within the software package.

2.4 Experimental Design

This study was conducted as a between-subjects repeated measures design with factor subject group. This factor had three levels: control (non-pilot, NVGP), VGP, and pilot. Each subject completed all 8 performance tasks on each of 3 different test days. The order of the tasks was randomized across subjects and test days.

2.5 Procedure

Once volunteers had consented to participate in the study, they were required to complete training on each of the 8 performance tasks. Subjects reported to the test facilities located at Wright-Patterson Air Force Base, OH and were provided verbal and written instructions as well as a brief demonstration for each of the eight tasks. Participants continued to practice all of the tasks during each training session until their performance varied less than 10% between training days. While training for the UAV landing task, the participants would attempt 6 landings per session. The scenario for the "Warship Commander" was repeated twice, and both the precision timing and motion inference tasks included 30 trials. Of the CANTAB tasks, the rapid information processing task was programmed to take four minutes (not including warm-up), the spatial recognition memory task included 4 repetitions, and the delayed matching-to-sample task incorporated two sets of 20 stimulus presentations. Training for the MAT-B task required a minimum of five training sessions. For the first training sessions, participants completed two ten-minute scenarios. On the fourth day, the duration of each of the two scenarios was increased to 20 minutes each. Finally, participants completed a single session of 30 minutes on the fifth day.

Once trained on a particular task, the task was eliminated from future training sessions. When the performance criteria had been met on all of the performance tasks, the subject was considered trained and ready for his/her testing sessions.

All subjects were required to complete three test sessions, each on a different day. Within each test day, the subject would complete all eight performance tasks in a randomized order. Prior to each task, they were reminded of the task instructions. A one-minute rest period was provided following each task to provide investigators time to prepare the next task in the test block, and to provide the subject time to recover. The number of trials or duration of the task in each test session was exactly the same as it had been during the training sessions with the following exceptions: the UAV landing was only repeated 3 times, Warship Commander was run once instead of twice, and the MAT-B was completed once for 30 minutes. The subject was released to return home or to his/her normal duties after completing all of the eight tasks.

3.0 RESULTS

3.1 General

All data were analyzed using a repeated measures Univariate or Multivariate analysis. Bonferroni post-hoc tests (α=0.05) were then conducted to perform pairwise comparisons. (The primary independent variables were Subject Type (video-gamers, pilots, or control) and test day (1, 2, or 3). The dependent variables were repeated performance measures gathered on each of the eight tasks (UAV Landing Task, Warship Commander, MAT-B, Delayed Matching to Sample, Rapid Visual Processing, Spatial Recognition Memory, Motion Inference, and Precision Timing). Significance tests were conducted with an alpha level of 0.05.

3.2 UAV Landing Task

The dependent variables of interest in this task were glide slope RMSE, vertical velocity at touchdown, and airspeed at touchdown. Data values for the ANOVA were averaged for each session.

For glide slope, there was a significant main effect for Group [$F(2,237) = 14.628$, $p = .000$] (Figure 1). The video-gamers' mean was 40.982 (*SEM* = 3.244), the pilots' mean was 30.461 (*SEM* = 2.251) and the controls' mean was 57.060 (SEM = 4.407). A Bonferroni post-hoc test (α=0.05) was used to examine differences between the groups. The results found a significant difference (p=.004) between the control group and the VGP group. The Bonferroni post-hoc test (α=0.05) also found a significant difference (p=.000) between the control group and pilot group.

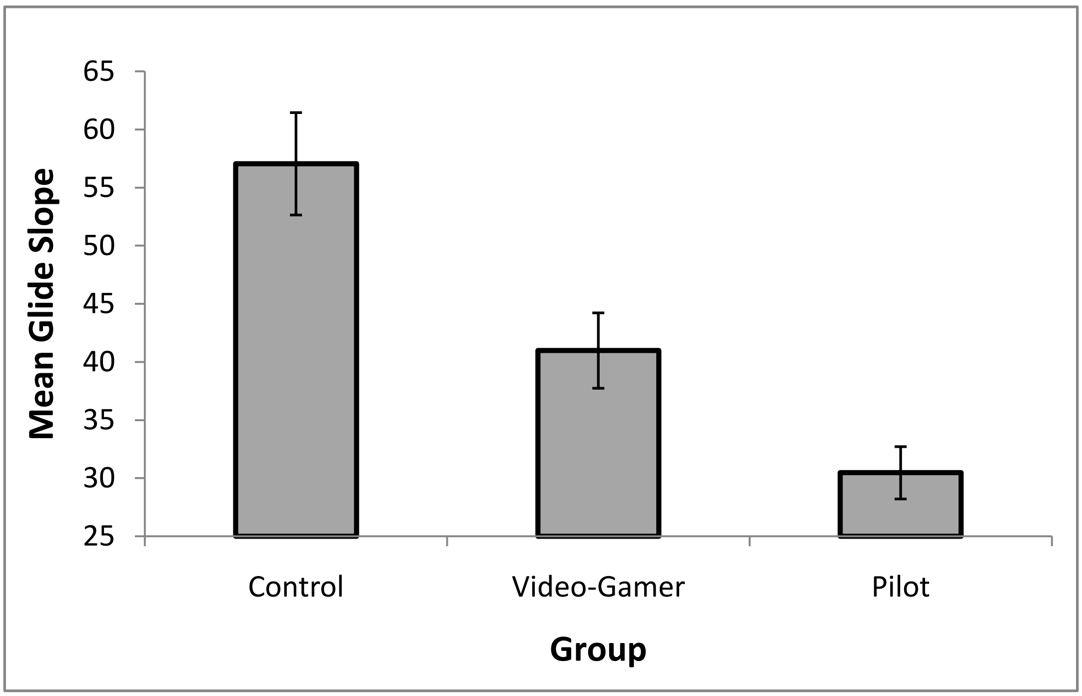

Figure 1. Mean glide slope of each group. Error bars are standard error of the mean

For vertical velocity, there was a significant main effect for Group [$F(2,237) = 15.799$, $p = .000$] (Figure 2). The video-gamers' mean was -209.244 (SEM = 15.829), the pilots' mean was -185.529 (SEM = 15.043) and the controls' mean was -419.242 (SEM = 51.436). A Bonferroni post-hoc test (α=0.05) was used to examine differences between the groups. The results found a significant difference (p=.000) between the control group and the VGP group. The Bonferroni post-hoc test (α=0.05) also found a significant difference (p=.000) between the control group and pilot group

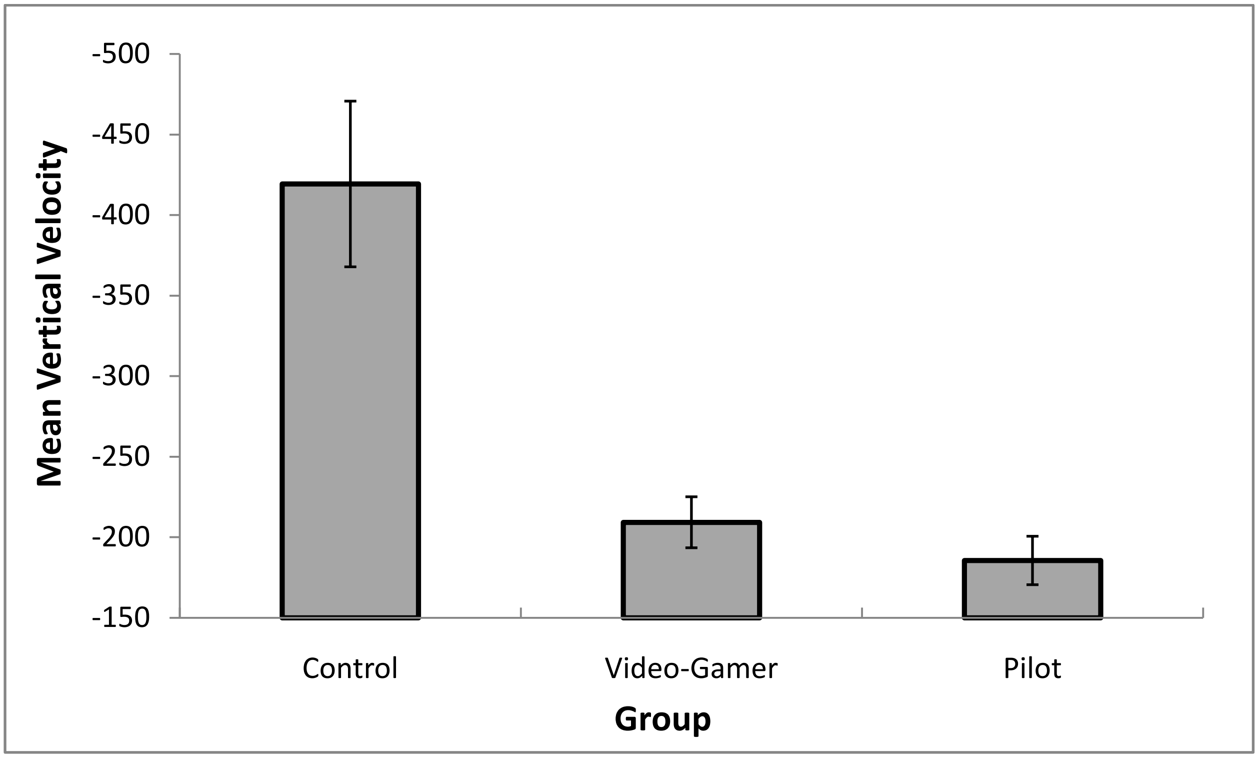

Figure 2. Mean vertical velocity of each group. Error bars are standard error of the mean

For airspeed, there was a significant main effect for Group [$F(2,237) = 16.750$, $p = .000$] (Figure 3). The video-gamers' mean was 62.141 (SEM = 1.052), the pilots' mean was 57.370 (SEM = 0.803) and the controls' mean was 66.713 (SEM = 1.408). A Bonferroni post-hoc test (α=0.05) was used to examine differences between the groups. The results found a significant difference (p=.016) between the control group and the VGP group. The Bonferroni post-hoc test (α=0.05) also found a significant difference (p=.000) between the control group and pilot group.

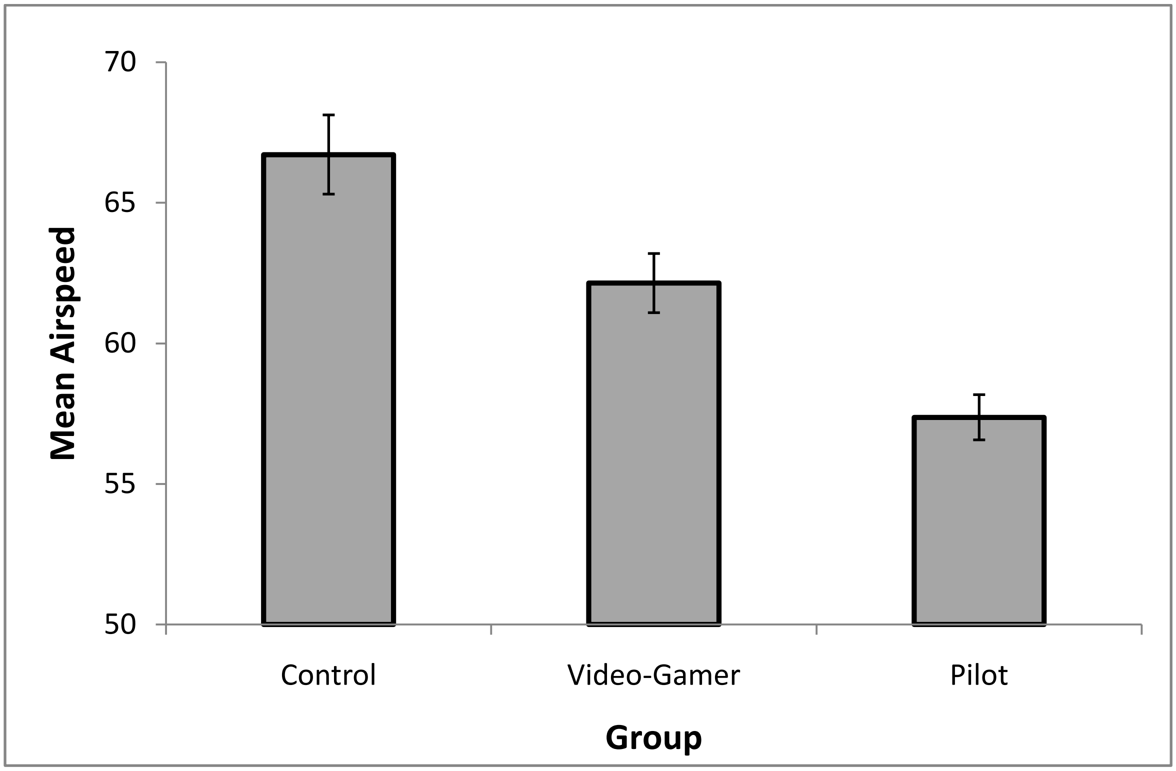

Figure 3. Mean airspeed of each group. Error bars are standard error of the mean

3.3 Warship Commander Task

The dependent variables evaluated in the Warship Commander task were final score, number of correct button presses, and number of incorrect button presses. Data values for the ANOVA were averaged for each session.

There was a significant main effect for Group [$F(2,234) = 3.861$, $p = .022$] on final score (Figure 4). The mean for the video-gamer group was 594.28 (SEM = 8.708), while the pilot group mean was 563.33 (SEM = 8.787), and the control group mean was 568.21 (SEM = 8.224). A Bonferroni post-hoc test ($\alpha=0.05$) was used to examine differences between the groups. The results found a significant difference ($p=.030$) between the VGP group and the pilot group. There was also a significant main effect found for target aircraft Wave [$F(2,234) = 7.043$, $p = .001$] (Figure 5). The participants' mean score for Wave 1 was 554.20 (*SEM* = 8.775), their mean score for Wave 2 was 572.70 (*SEM* = 9.481), and their mean score for Wave 3 was 599.66 (SEM = 7.069). A Bonferroni post-hoc test ($\alpha=0.05$) was used to examine differences between the waves. The results found a significant difference ($p=.001$) between wave 1 and wave 3.

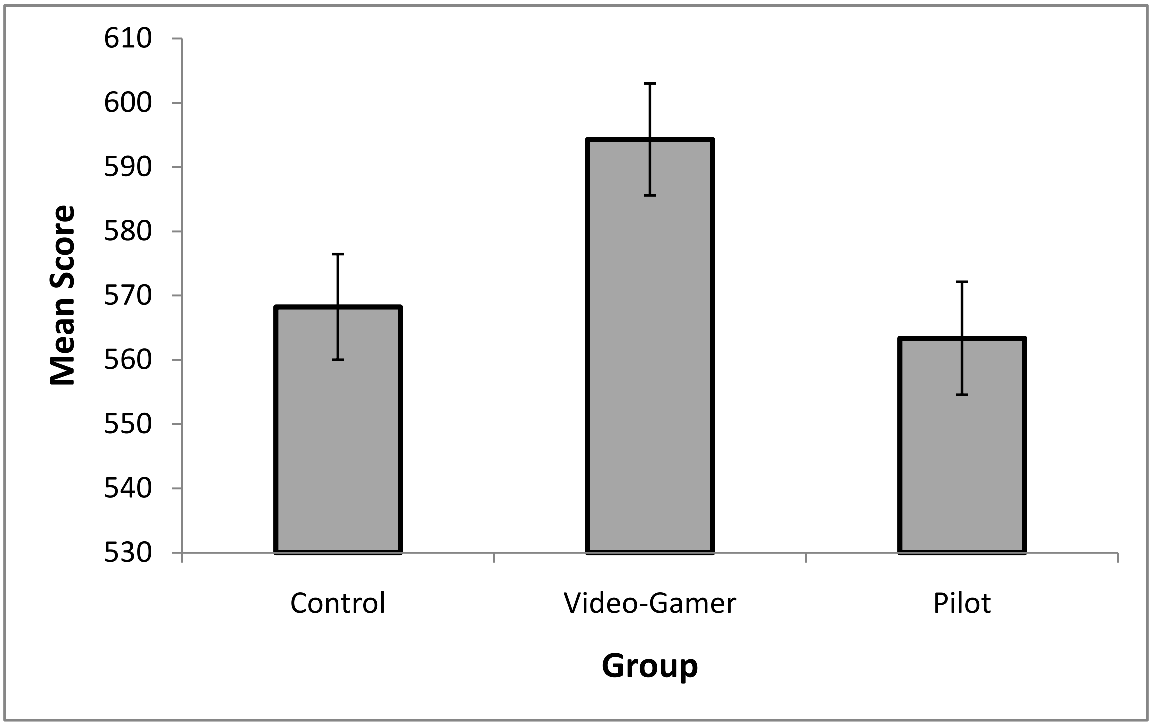

Figure 4. Mean score of each group. Error bars are standard error of the mean

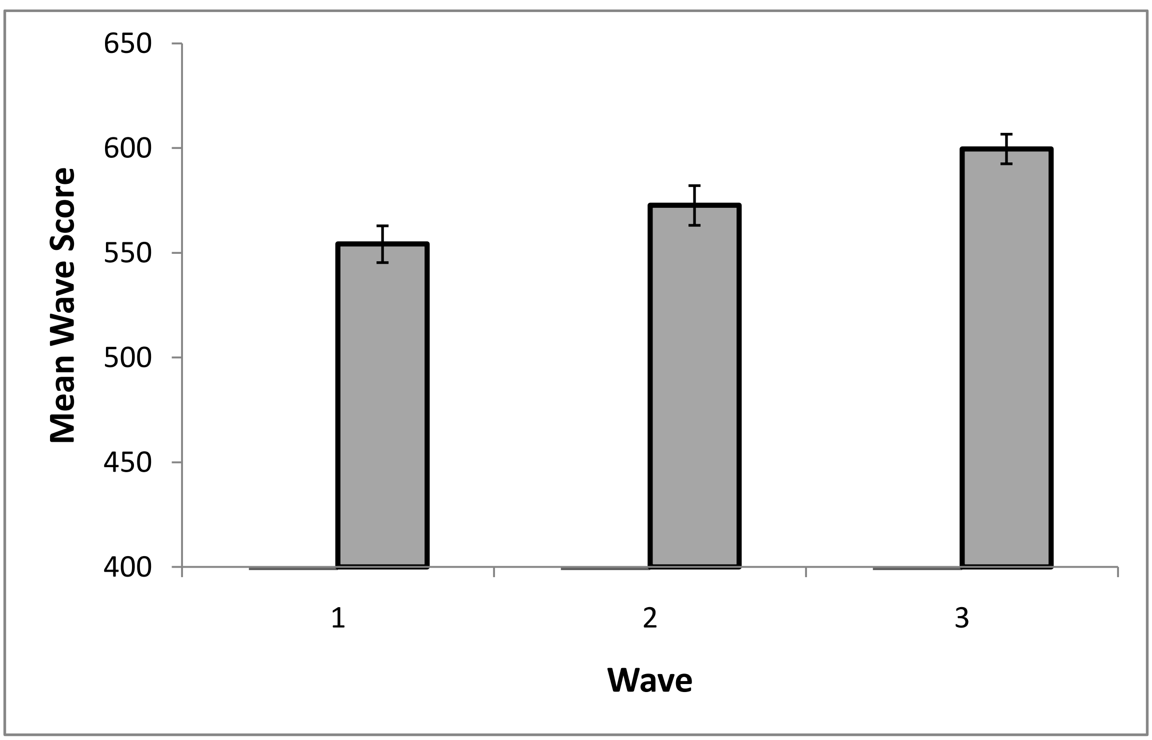

Figure 5. Mean score of each wave. Error bars are standard error of the mean

3.4 Motion Inference

The dependent variables of interest in this task were absolute value of angle between the ideal stopping point and the true stopping point. However, this task also included a secondary task that required the subject to indicate whether a set of four letters contained a vowel. As a result, the parameters letter correct, letter incorrect, and number of misses, were also included in the analyses. Data values for the ANOVA were averaged for each session.

For the absolute value of angle difference, there was a significant main effect for Group [$F(2,2689) = 4.781$, $p = .008$] (Figure 7). The mean for the video-gamer group was .4965 (SEM = 0.033), the pilot group was .7154 (SEM = 0.040), and the control group was 2.087 (SEM = 0.044). A Bonferroni post-hoc test (α=0.05) was used to examine differences between the groups. The results found a significant difference (p=.013) between the control group and the VGP group. There was also a significant difference (p=.042) between the control group and the pilot group.

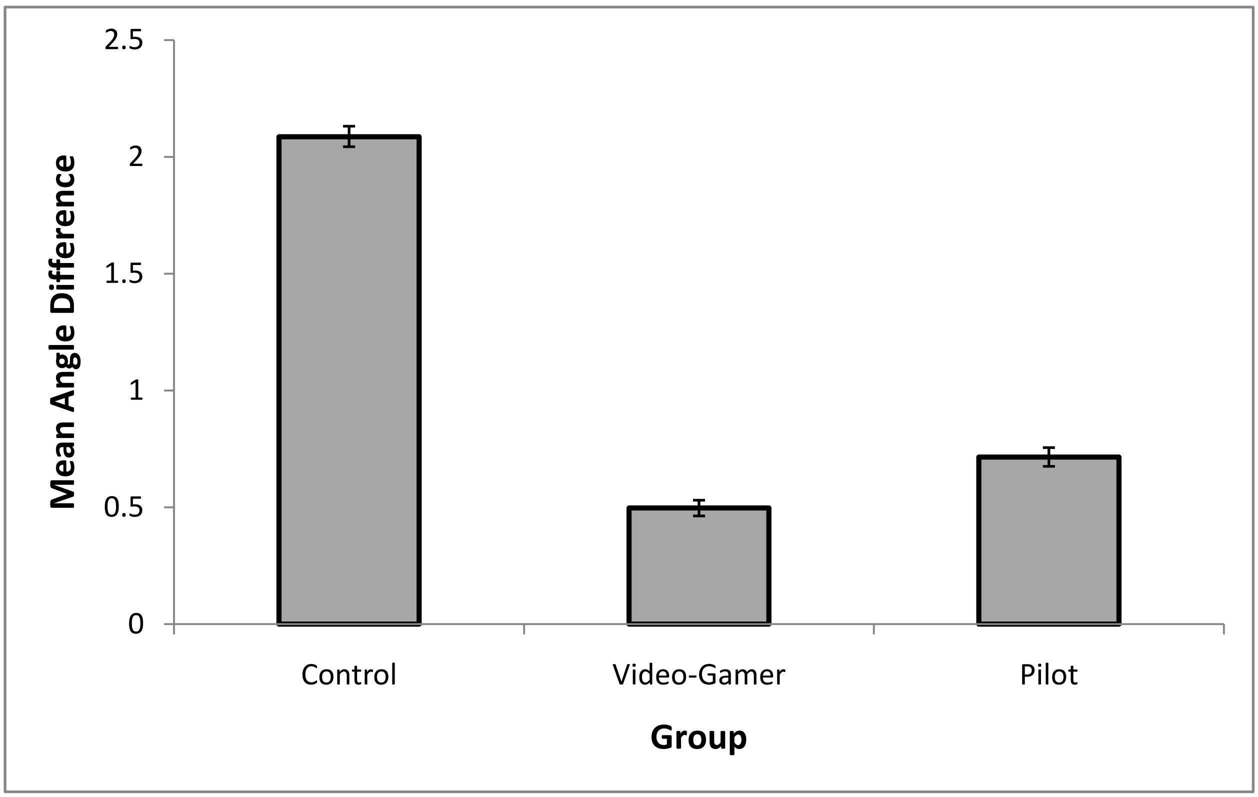

Figure 6. Mean absolute value of the angle difference. Error bars are standard error of the mean.

3.5 MAT-B

There are 30 dependent variables in this task as noted by Comstock and Arnegard (1992). The dependent variables of interest for this study were the mean absolute deviation of Tank A and Tank B from 2500, Tank A mean, Tank B mean, and tracking mean. Data values for the ANOVA were averaged for each session.

For the mean absolute deviation of Tank A and Tank B from 2500, there was a significant main effect for Group [$F(2,74) = 3.635$, $p = .031$] (Figure 8). The video-gamers' mean was 4.646 (SEM = 1.046), the pilots' mean was 2.032 (SEM = 0.237), and the controls' mean was 3.509 (SEM = 0.601). A Bonferroni post-hoc test (α=0.05) was used to examine differences between the groups. The results found a significant difference (p=.029) between the control group and the pilot group.

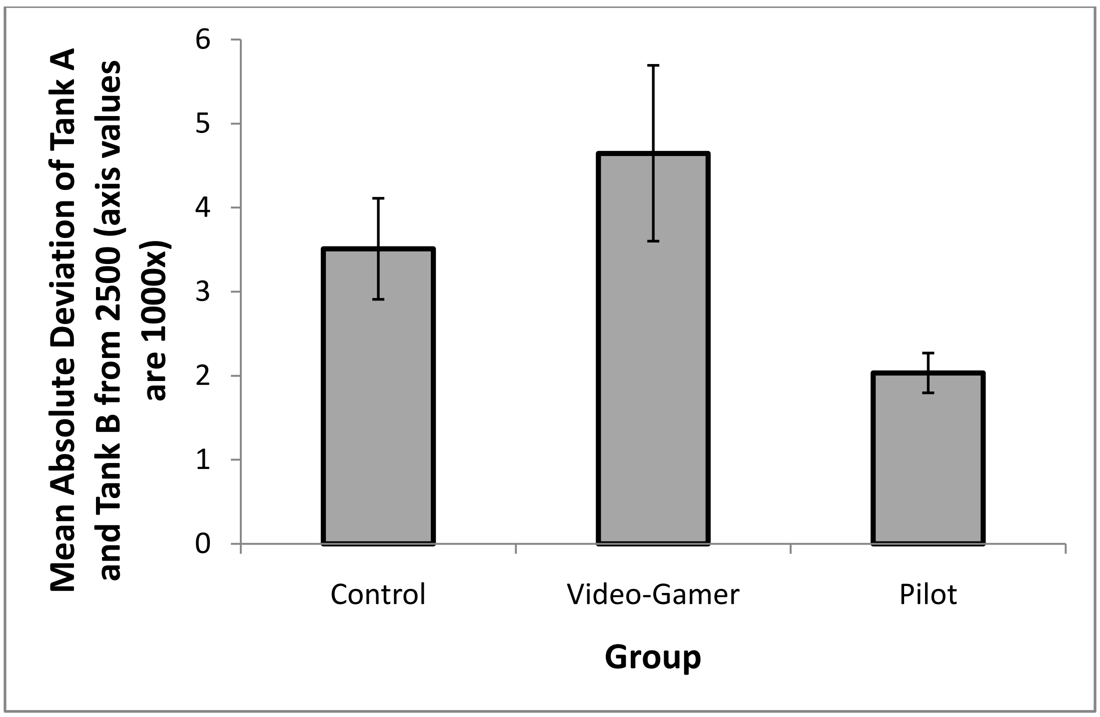

Figure 7. Mean absolute deviation of Tank A and Tank B from 2500. Error bars are standard error of the mean.

There was also a significant main effect for Group [$F(2,74) = 4.454$, $p = .015$] on the mean value of Tank A (Figure 9). The video-gamers' mean was 2.573 (SEM = 0.291), the pilots' mean was 2.488 (SEM = 1.313), and the controls' mean was 2.584 (SEM = 0.401). A Bonferroni post-hoc test (α=0.05) was used to examine differences between the groups. The results found a significant difference (p=.046) between the control group and the pilot group. There was also a significant difference (p=.035) found between the VGP group and the pilot group.

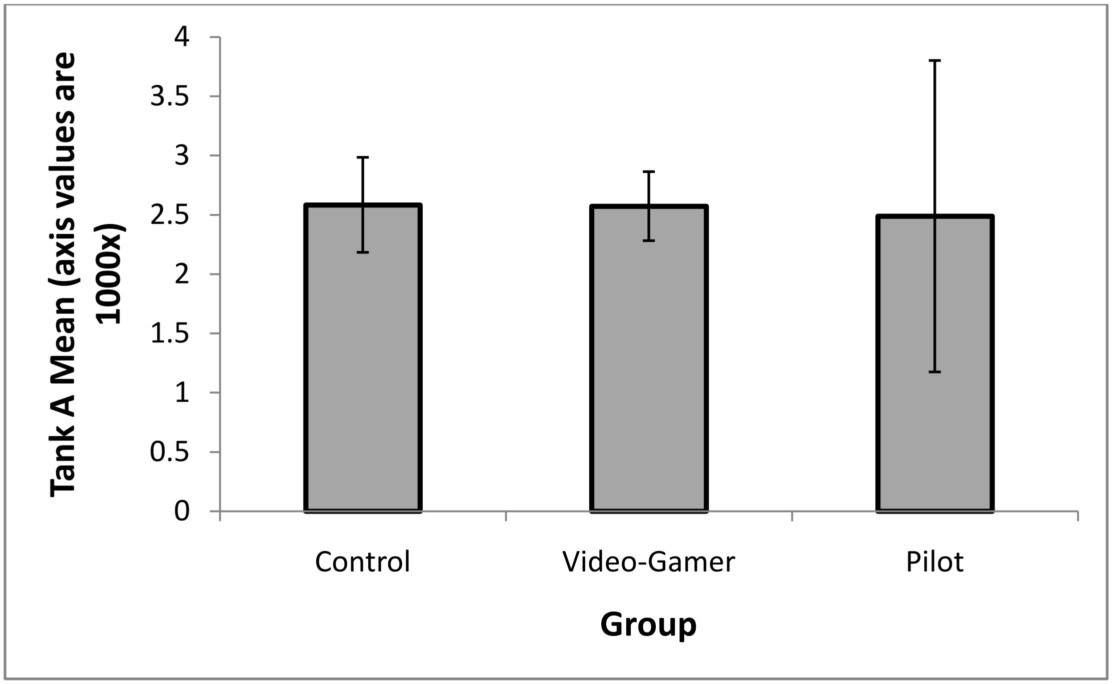

Figure 8. Mean of Tank A. Error bars are standard error of the mean.

Likewise there was a significant main effect for Group [$F(2,74) = 6.600$, $p = .002$] on the mean of Tank B (Figure 10). The mean for the video gamers was 2.563 (SEM = 0.328), whereas the pilots' mean was 2.489 (SEM = 1.326), and the controls' mean was 2.513 (SEM = 0.236). A Bonferroni post-hoc test ($\alpha=0.05$) was used to examine differences between the groups. The results found a significant difference (p=.031) between the control group and the VGP group. There was also a significant difference (p=.003) found between the VGP group and the pilot group.

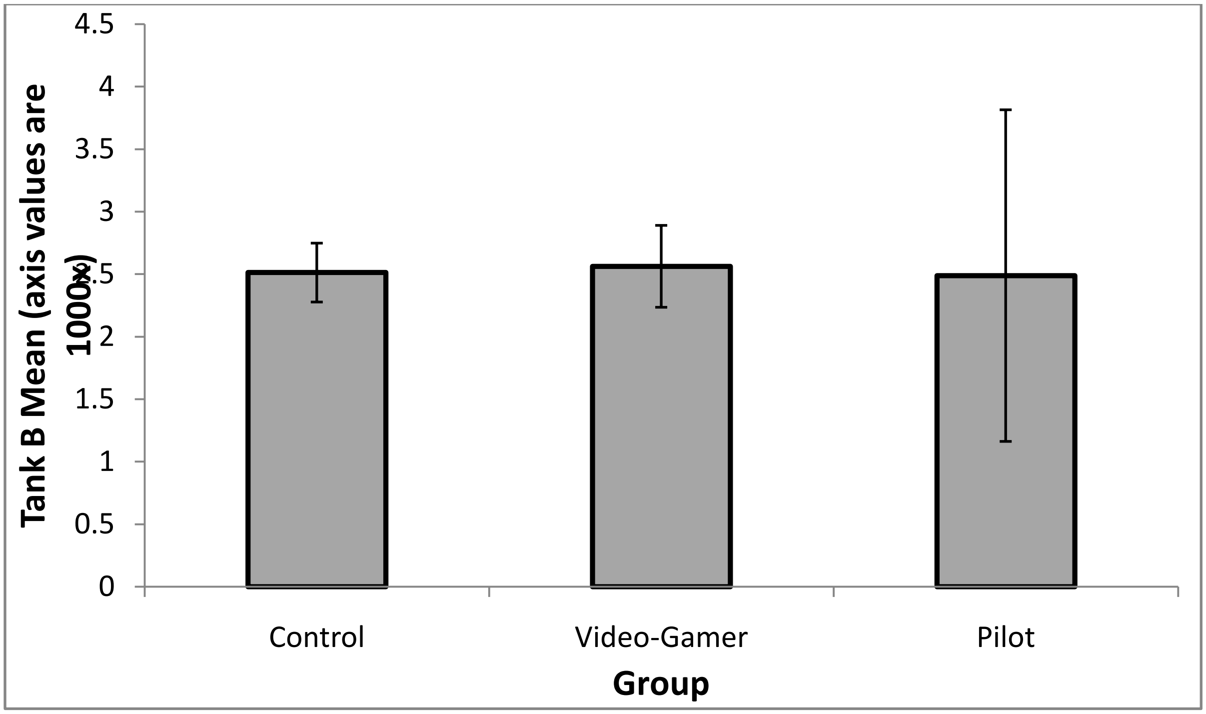

Figure 9. Mean of Tank B. Error bars are standard error of the mean.

Within the tracking subtask, there was a significant main effect for Group [$F(2,74) = 6.352$, $p = .003$] on root mean square error from the center (Figure 11). The video-gamers' mean was 4.193 (SEM = 0.506), the pilots' mean was 3.438 (SEM = 1.045), and the controls' mean was 4.307 (SEM = 0.294). A Bonferroni post-hoc test ($\alpha=0.05$) was used to examine differences between the groups. The results found a significant difference ($p=.005$) between the control group and the VGP group. There was also a significant difference ($p=.020$) found between the control group and the pilot group.

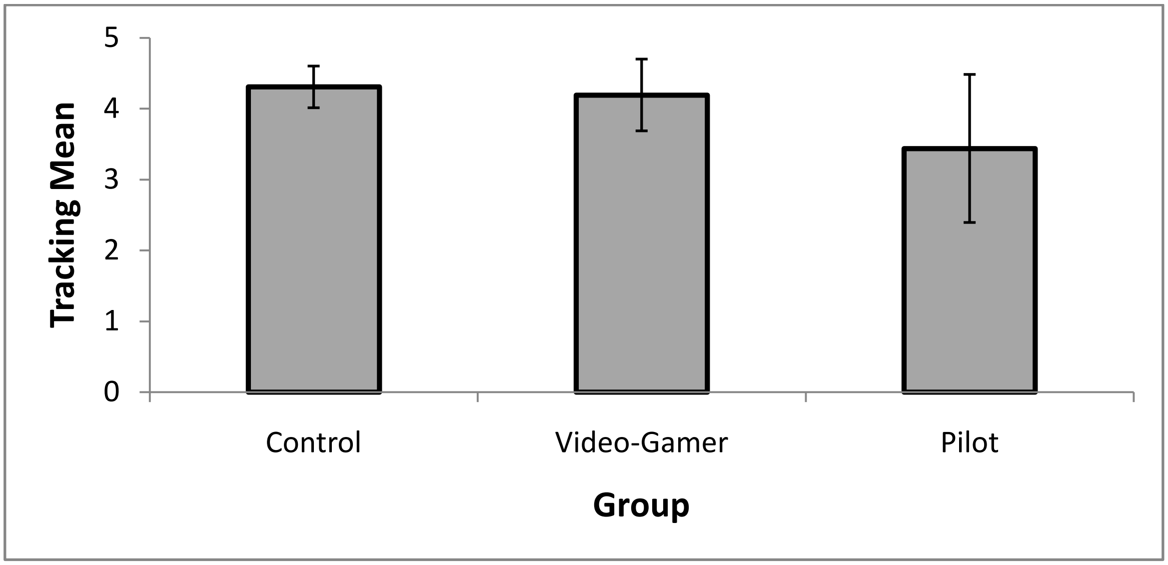

Figure 10. Mean of the tracking task. Error bars are standard error of the mean.

3.6 CANTAB Tasks and Precision Timing

Finally, there were no significant differences in performance between subject groups for the remaining tasks including the three CANTAB tasks (delayed match-to-sample, rapid visual processing, and spatial recognition memory), and precision timing.

4.0 DISCUSSION

Given the high operations tempo and the seemingly insatiable demand for more unmanned systems to be deployed in the battlefield, finding methods of reducing or accelerating operator training is crucial for meeting these new requirements. One such method lies in examining the background of the operator group in an effort to find the optimal operator to control unmanned aerial systems (UAS). Perhaps by identifying a group familiar with the type of control environment found in today's UAS's, recruits would be easier to train, faster to learn, and enjoy superior performance due to phenomena such as reduced negative transfer and inherent advanced cognitive skills necessary for the UAS operations. Given the similarities between the UAS and video game environment, this study attempted to discover whether video game players (VGPs) possess superior UAS-relevant cognitive skills when compared to manned aircraft pilots.

The data suggest that pilots do not hold a performance advantage over VGPs in landing a simulated Predator aircraft, although groups performed significantly better than the control group. While pilots outperformed VGPs in our first study (McKinley, et al., 2008), the only statistically significant difference had been the glide slope RMSE parameter. As a result, it was not surprising that both pilots and VGP groups maintained similar performance in this experiment. While touchdown airspeed was significantly lower in the pilot group than the VGP group, the means were all within the acceptable range (<70 knots). Thus, landing at airspeed lower than the threshold did not indicate superior landing performance.

The results from the warship commander task illustrated that the VGP group was able to outperform both the pilot group and control group. The VGPs maintained a significantly higher overall score on the task and did so with significantly fewer incorrect responses when compared to the pilot group. Given that this performance task was primarily visual, required tracking multiple targets, and making responses quickly, this result is not unexpected. Previous research suggests that VGPs possess superior spatial visualization skills evidenced by faster stimulus-response mappings (Castel, *et al*., 2005; Dorvil & Pepin, 1986), enjoy better eye-hand coordination (Griffith *et al*., 1983), faster reaction times (Yugi, 1983), ability to track more objects (Green & Bavelier, 2005), are able to track objects moving at greater speeds (Boot, et al., 2008), and have improved control over selective attention (Green & Bavelier, 2003) when compared to non-video game players. The primary mission of existing UAS platforms is intelligence, surveillance, reconnaissance including a limited air-to-ground attack capability. Typically, these missions involve tracking multiple possible targets, identifying threat levels, collecting visual intelligence, and responding to threats quickly and appropriately. With the similarities between the cognitive skills necessary to perform these UAS mission tasks and those needed in the Warship commander task, it is reasonable to expect that the superior performance demonstrated by the VGPs might have direct applicability to UAS operations.

In addition, the data suggest the VGP group on average performed significantly better when compared to both pilots and control group subjects on the "motion inference" task. This task refers to the ability to "perceive and process both the motion of an object and estimate the trend information so as to predict its position at a future point in time even when direct line-of-sight cannot be maintained continuously," (McKinley, 2009). Part of this superior performance may result from improved reaction times acquired through extensive video game play. This is supported by previous findings from Clark, Lanphear, and Riddick (1987). As cognitive skills enhanced by extensive video game play appear to transfer to other cognitive tasks and environments (Frederiksen & White, 1989; Gopher, Weil, & Bareket, 1994; Green and Bavelier, 2007), this finding indicates VGP's may enjoy an enhanced ability to track and fire upon a target, especially in urban areas where line-of-sight is difficult to maintain at all times.

The data also showed statistically significant differences in performance for the MAT-B task. Specifically, the pilots exhibited less deviation from the optimal "tank level" on the resource management subtask and were able to maintain a mean tank level that was closer to the optimal level (2500 units) than the VGPs or control groups. The pilots also exhibited superior tracking ability on the 2-D tracking subtask as denoted by a lower mean deviation from the origin. These results indicate that the although existing evidence suggests VGPs can track more objects and react more quickly to visual stimuli, these cognitive abilities may not directly aid in the performance of multiple tasks concurrently, especially when the tasks are highly dissimilar and require activation of disparate regions of the brain. The MAT-B task incorporates judgment and short term memory (prefrontal cortical regions such as the dorsolateral prefrontal cortex (DLPC)) (Courtney, et al., 1998), auditory processing (superior temporal lobe), visual monitoring (visual association cortices), and compensatory tracking (supplemental motor area (SMA), primary motor cortex, basal ganglia, cerebellum). Additionally, because the MAT-B tasks were designed to resemble those present in piloting manned aircraft, it is possible that the pilot's extensive training in this area yielded a considerable advantage over both the control and VGP subject groups. Nevertheless, such abilities remain necessary for such platforms as the MQ-1 Predator and MQ-9 Reaper due to the fact the operator manually flies the aircraft and mush continuously monitor aircraft state information and respond to alarms/radio calls. Thus, in terms of multi-tasking, the evidence suggests the pilots still hold a significant advantage when compared to non-pilots, regardless of video game play experience.

5.0 CONCLUSIONS

Extensive video game play certainly appears to correspond with improved performance in specific cognitive abilities. Several of these such as improved reaction times, ability to track more visual stimuli, superior spatial visualization skills, and track objects moving at greater speeds notionally have applications to improving UAS operator performance. Aircraft control and landing skills were not shown to be significantly different between pilots and VGPs, but both groups were superior when compared to non-pilot, non-video game players. This result suggests that video game playing may engender motor control and coordination skills that have direct application to UAS piloting. Nevertheless, the results from the current experiment shows that pilots tend to hold advantages in skills directly relevant to multi-tasking and attention switching. Because existing UAS platforms continue to require such skill sets, pilots may maintain an advantage over non-pilots in operating remotely-piloted UAS systems such as the MQ-1 Predator and MQ-9 Reaper. However, VGPs did exhibit superior performance on identifying, finding, and tracking visual targets, which is consistent with our first study (McKinley, et al., 2008). These results provide initial evidence that VGPs may in fact be a suitable surrogate for manned aircraft pilots in UAS operations although further study of the benefits of video game playing on UAS operator performance is warranted.

6.0 REFERENCES

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LIST OF ACRONYMS

Unmanned Aerial System	UAS
Video Game Players	VGP
Multi-Attribute Task Battery	MAT-B
Weapons Systems Officer	WSO
Non-Video Game Players	NVGP
Unmanned Aerial Vehicle	UAV
Ground Control Station	GCS
Cathode Ray Tube	CRT
Cambridge Neuropsychological Assessment Battery	CANTAB
Rapid Visual Information Processing	RVP
Spatial Recognition Memory	SRM
Delayed Matching to Sample	DMS
Identification, Friend or Foe	IFF
Dorsolateral Prefrontal Cortex	DLPC